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A SHORT TERM FORECASTING MODEL FOR SECOND HOMES IN NORTHEASTERN ARIZONA

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1. INTRODUCTION

Much of the recent non-urban land development in the United States has taken the form of subdivisions and subsequent land sales to individuals who are seeking only a financially attractive outlet for their savings. However, a growing share of those purchasing rural land are doing so with the idea of constructing some type of second home; that is, "... a property owned or rented on a long lease as the occasional residence of a household that usually lives elsewhere."[1] In fact, according to the 1970 CENSUS OF HOUSING (1972), about 5 percent of the roughly 60 million households in this country reported owning a second home. Moreover, CLOUT (1972) has predicted that the national stock of second homes may double by 1980; a growth rate that is in excess of the net rate of household formations.

This growth in rural development activity has sparked concern for possible unwanted social, economic, and environmental side-effects. In academic circles, this concern has manifested itself in case studies and other descriptive accounts of the problems coincident with second home construction in specific locations. Papers by WOLF (1951, 1956, and 1965). FINE and TUTTLE (1966), NICHOLS (1968), TOMBAUGH (1968a, 1968b), RAGATZ (1970), THOMPSON and LEWIS (1973), and LEWIS (1975), are illustrative of this point. There is no question that these studies

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[1]This definition, which is due to DOWNING and DOWER (1973), is presented here largely because of its generality. There simply is no widely accepted definition that would result in a determination of precisely what is and what is not a second home. For a useful discussion of this point see COPPOCK (1977, pp. 2-4).

have made a valuable contribution by bringing the key issues associated with second homes into sharper focus. Nevertheless, as ROBERTSON (1977, p. 122) argued, progress within this body of literature "... has been limited, for the most part, to increasing the detail and accuracy of this descriptive work." Obviously, the lack of data on both second homes and their owners has severely hampered the development of analytical or model-oriented approaches to this subject. However, such approaches are of increasing importance for planning purposes because, as will be indicated in greater detail momentarily, the negative aspects of second home development can, in many cases, be reduced only when forecasts of future construction activity are available.

The purpose of this report is to report on an inexpensive and workable approach to forecasting second home construction that is thought to have possibilities for application in many development sites. Specifically it will be argued that: (1) the number of second homes may be adequately approximated from data on seasonal residential electric utility connections and (2) changes in the number of such connections, and thus in the number of second homes, can be predicted from a time series forecasting model of the BOX and JENKINS (1976) type. This technique will then be illustrated using data from Navajo and Apache counties in Arizona. The time series forecasts themselves are contained in the fifth section while some preliminary material regarding the policy issues involved in second home development activity, the choice between available forecasting models and some background information on the study area is provided in the two sections that follow. The sixth and final section contains a brief conclusion.

2. POLICY ISSUES IN SECOND HOME DEVELOPMENT

As RAGATZ (1969) observed, the distribution of second homes in the United States broadly reflects the distribution of population. The proportion of the population owning second homes does not vary greatly from state to state and second homes tend to be located in close proximity to the owners' primary residence. However, within any given state, second home development sites have shown a marked tendency to be clustered around centers for outdoor recreational activity such as bodies of water, mountains, or forests. Because of this concentration, and because the use of second homes is by definition seasonal in nature, development activities have frequently had measurable economic and environmental impacts that have been of concern to regional planners.[2] For example, second home construction contributes to increased property tax collections through gains in the tax base associated with the building itself together with possible increases in surrounding property values. At least a portion of these tax collections, though, must be used to finance the increased provision of such public services as transportation, police and fire protection, and possibly education demanded by the new seasonal residents. Moreover, during the construction phase, second home development may result in soil erosion causing excessive siltation of surrounding lakes and streams. In addition, to the extent that second homes are located in areas lacking both adequate sewage treatment facilities and soils suitable for septic systems, ground water contamination can become

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[2] It is of interest to observe that LEWIS (1975), in an Eisenhower Consortium publication has surveyed some of the costs and benefits of second home development from the point of view of county government. Readers interested in more detail on this subject than is provided here are referred to this study.

a serious problem. In fact, the California Environmental Quality Study Council has estimated (REILLY, 1973, p. 277) that 37 percent of the stream mileage in the Sierra Nevada Mountains has been damaged by either the construction or use of rural subdivisions and a representative of the Sierra Club has described these subdivisions as the most dangerous environmental threat to this area since placer mining (PARSONS, 1972, p. 7).

As even casual reflection will reveal, many of the above negative aspects of second homes, such as the sewage treatment problem, can be mitigated only by adopting sufficiently stringent measures regarding matters such as siting, density of development, and provision of services prior to the time construction begins. Therefore, it is essential that local planners have a mechanism capable of providing advance warning as to the scale and location of proposed developments in their area. This point has been explicitly recognized in at least two previous studies by investigators who have attempted to construct predictive models of the second home development process. Since these studies provide a useful background in motivating the time series model to be discussed in the Section 5, each will be briefly reviewed.

3. SECOND HOME FORECASTING MODELS

RAGATZ (1977) has proposed a rather general model for forecasting future demands for second homes. This model is based upon stratifying the population (either for the nation as a whole or for a region) into classes that depend upon the following set of factors: age, education, and occupation of household head; family size and income; place of permanent residence; and past experience with rural living. Once

stratification has been accomplished, the next step would be to determine the number of people in each class together with a set of class-specific second home ownership probabilities. While the number of persons per class could be determined for any time using census data together with a cohort-survival projection, the ownership probabilities could probably be obtained only through special surveys and an extensive knowledge of credit market conditions and public policies influencing the decision to purchase second homes. In any case, if this information were available, the total quantity of second homes demanded could be calculated by summing the population weighted ownership probabilities over all classes. Finally, Ragatz suggests that in order to make a determination of local impacts, the total quantity of second homes demanded might be allocated to various geographic areas according to a set of location and product characteristics.

Quite obviously, Ragatz has proposed an extremely detailed model. Because there would be several categories within each of the above-mentioned strata, the number of population classes to be investigated would be enormous. To be sure, similar classes could be grouped together for analytical purposes. However, the fact remains that reliable data on the patterns of second home-ownership are simply unavailable from secondary sources. Consequently, the Ragatz procedure would require a very large initial expense for primary data before the model could provide any forecasts at all. Perhaps this explains why, at present, this model has not been implemented.

BURBY, DONNELLY, and WEISS (1972), on the other hand, were more successful in developing an operational model for predicting the incidence of second home construction. In particular, these authors sought to

forecast both the extent and location of shoreline and near-shoreline development near Lake Norman, North Carolina, and Lake Sidney Lanier, Georgia. After dividing all of the privately-owned land around both lakes into standard-sized plots, they estimated regression equations designed to explain whether a given plot would be developed. Even though they tried a large number of variables as regressors, the explanatory power of their equations was comparatively low; for their shoreline development equation, $R^2 = .21$, while for the near-shoreline equation, $R^2 = .40$. Nevertheless, these equations were used to isolate variables that appeared to impact on development most significantly. A simulation model incorporating the behavior of these key variables was then constructed in an effort to capture the increase in second home development around the two lakes. As might be expected from the previously described regression results, the simulation model was not especially successful in predicting present development patterns around the two lakes.

Despite its lack of predictive ability, it is difficult to be very critical of the model that Burby, Donnelly, and Weiss have proposed. The model represents a highly systematic and ambitious attempt to forecast the outcome of interactions between a large number of land owners, second home purchasers, and real estate intermediaries. In short, since one of their objectives was to predict not only the number but the exact locations where second homes would be constructed, the authors deserve credit that the model performed as well as it did. However, there is a real question as to whether local planners have either the time or the resources to develop and refine such an intricate forecasting tool. In fact, a far simpler model based exclusively upon easily obtained secondary data and the informed judgment of those familiar with the area may

actually generate predictions of equal quality. Also, as MILLIMAN (1971, p. 350) has argued, "It may be a wiser strategy to build simpler and less expensive models that might be kept operative and updated over time than to embark upon an expensive allout attempt to construct a 'grand' model that is not to be kept operative, used, and useful."

The final second home forecasting exercise to be reviewed in this section was conducted by BOND and DUNIKOSKI (1977). This report was primarily concerned with the impact of second homes on water availability rather than with methods of forecasting second home development activity. Nevertheless, in pursuing their stated objectives, the authors found it necessary to engage in some forecasting work. Both their forecasts and methods are thought to be of interest for two reasons. First, the Bond and Dunikoski study was an Eisenhower Consortium funded project. Second, since its area of interest lies in portions of Coconino, Yavapai, Gila and Navajo Counties in Arizona, there is some geographical overlap with the present study.[3]

In developing their forecasts, Bond and Dunikoski relied on two basic data sources. The first consisted of official maps prepared by the Forest Service for the Prescott, Apache, Coconino, Coronado, and Tonto National Forests in 1967. These maps provided enough detail so that individual structures within the forests could be identified. Those structures that were identified as "single residential" and were located in likely second home areas were classified as second homes. Second, Bond and Dunikoski also utilized 1976 data from the Arizona

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[3]See the Arizona map in BOND and DUNIKOSKI (1977, p. 26).

property tax rolls. Although there is no official second home category within this body of information, these authors classified parcels of property as containing second homes if: (1) the property was assessed at a rate of 15 percent of total valuation (2) the mailing address of the taxpayer indicates that his primary residence is elsewhere, (3) the property has a structure of a certain dollar value limit thereon.

By the author's own admission, these two data sources measured the number of second homes in the study area only imprecisely. For example, there was no way to clearly distinguish structures that were second homes from those used for other purposes from the Forest Service maps. Also, maps were not available for some portions of the study area. Moreover, the identification of second homes from tax records required some questionable and empirically unsubstantiated assumptions such as: (1) individuals truthfully report the rental/self-occupancy status of their property and (2) taxpayers will have bills sent to the address of their primary residence. In addition, it must be noted that the observations used in this study covered only the two years 1967 and 1976. As a consequence, Bond and Dunikoski's forecasts of the future number of second homes, which is reported in Table 1, must be treated with a measure of skepticism. Nevertheless, these predictions do illustrate both the lack of existing data on second homes in Central Arizona (and elsewhere) and the assumptions to which investigators are frequently forced to resort.

4. THE STUDY AREA

The remainder of this report will describe an easily implemented and inexpensive model for forecasting second home development in two

TABLE 1

ESTIMATED SECOND HOME INVENTORY

IN THE BOND-DUNIKOSKY STUDY AREA

Year	Inventory
1975	10,545
1980	15,800
1985	21,100

Arizona Counties; Navajo and Apache. This area of the state attracts summer home buyers for various reasons, one of the most important of which is the pleasant summer weather. Many recreational opportunities are available as well such as fishing, boating, camping and hunting; in addition the area offers exceptional scenic adventures including the White Mountains, Petrified Forest National Park, and the Mogollon Rim.

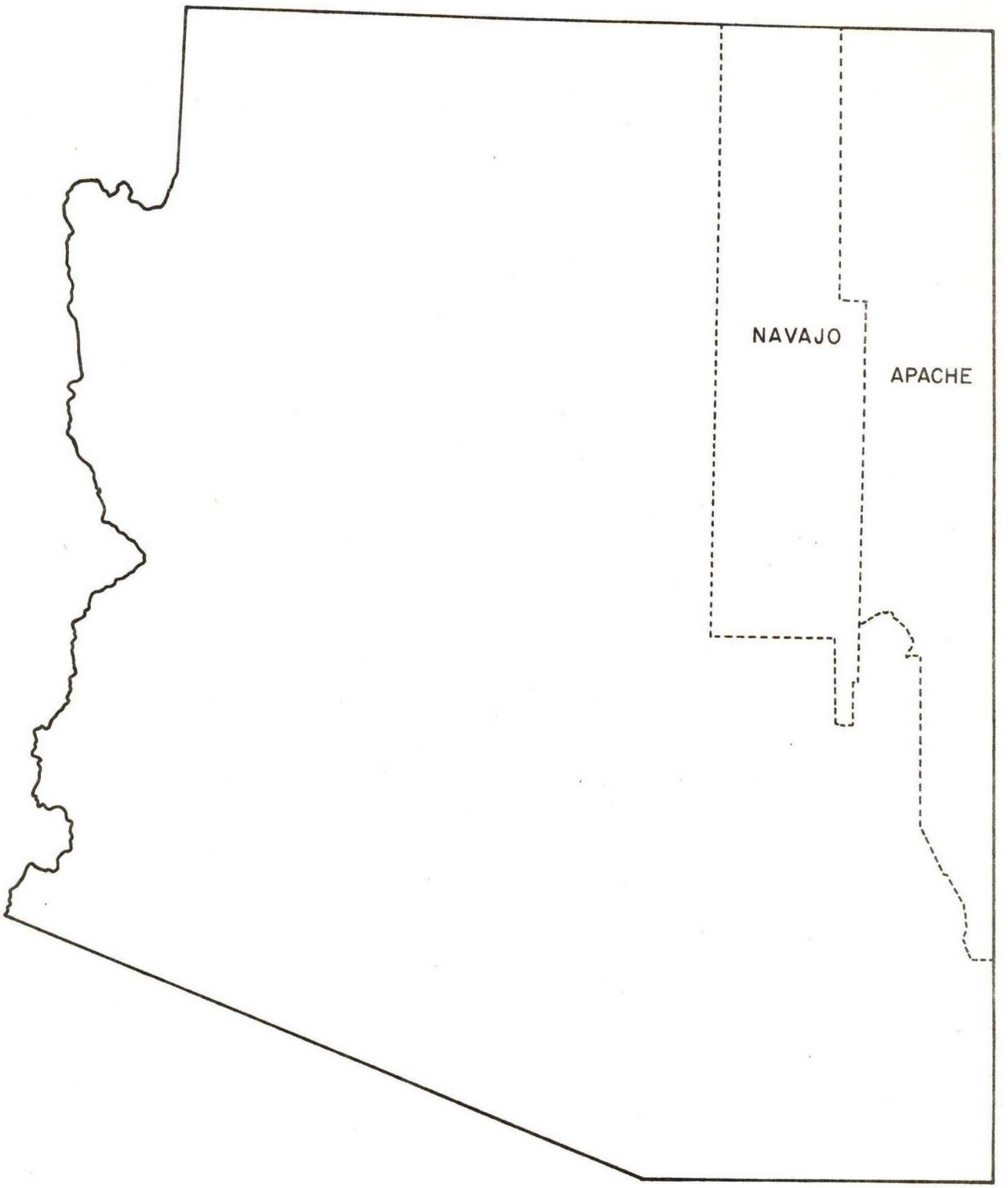
The largest majority of summer homes appears to be concentrated in the Show Low, Pinetop and Lakeside areas. Well-stocked lakes and streams are an important factor in determining the location of these summer homes. There are several popular lakes in the Show Low area where boating and abundant fishing attract many in the market for a second home. Also, the Apache Sitgreaves National Forest, Fort Apache Indian Reservation, and the White Mountain and Mogollon Rim areas attract still more.

As previously indicated, data measuring the number of second homes currently in existence, the pattern of growth over previous years together with the factors which have contributed to this growth, are simply not available. Consequently, it was necessary to conduct some fieldwork prior to constructing the desired forecasts. Personal interviews with local figures were thought to be essential to understanding factors such as: (1) the geographical distribution of second homes in the two counties, (2) the types of second homes being constructed, (3) future constraints to the construction of second homes and, (4) data sources that might be helpful in measuring the number of second homes. This section provides a summary of a series of such interviews conducted at various times during the summer of 1977. Hopefully, this material will be as helpful to the reader in gaining a background to the forecasting exercise as it was to ourselves.

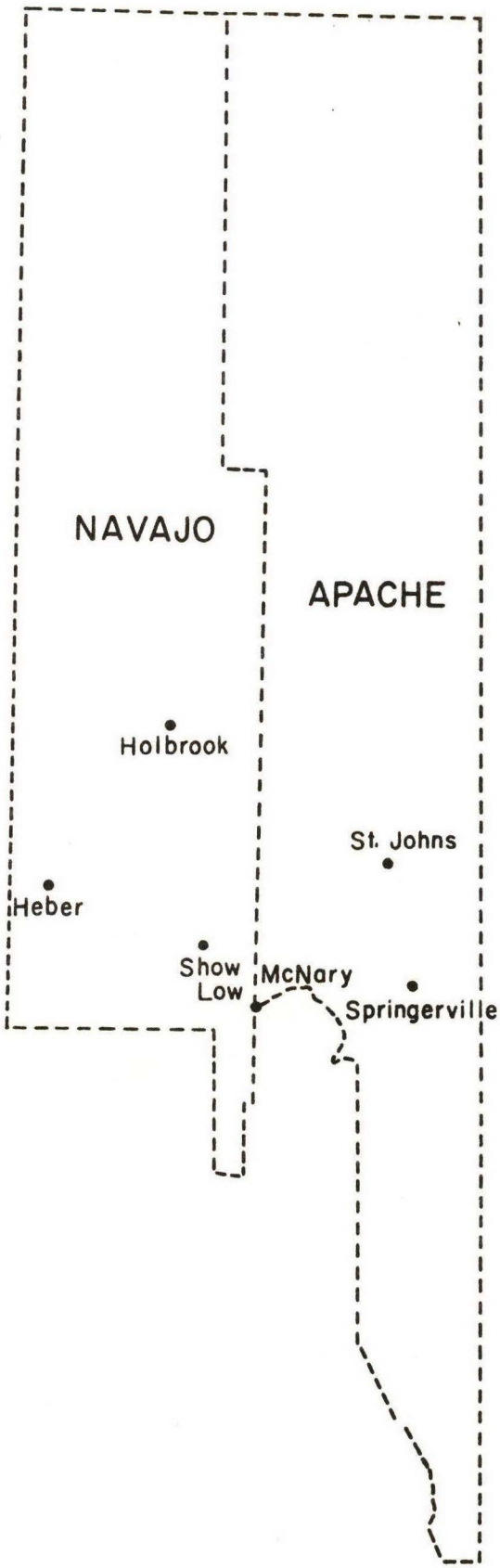
A good point of departure for the interviewing process appeared to be the Chamber of Commerce in Show Low (see Maps 1 and 2). The Director of the Chamber was, however, not able to give any information and was not very encouraging about the feasibility of gathering such data. He suggested a check with City Hall in the hopes that water billing records might distinguish between residents that are permanent and those that are not.

The gentleman interviewed at City Hall indicated that there had been a large amount of growth in second homes in the Show Low area over the past three years. He offered access to the water billing files which do distinguish between permanent and temporary residents. Totals, however, were not available, and a visual inspection of each individual customer's billing records by month would have been necessary to determine the status of the resident. This process would have been very time consuming and cumbersome. In addition there are undoubtedly a large number of second home-owners in the area whose water is self-provided by means of wells, rather than city-provided. It was suggested that some of the local real estate agents would probably have more direct knowledge of the market for second homes.

Two realtors in Show Low, Jerry Hall at Show Low Realty and Harold Vaughn at White Mountain Realty, were contacted. Hall stated that a number of second homes in the immediate Show Low area are located at the Fairway Parks Country Club but that, second homes are also scattered about the Pinetop and White Mountain areas. A lengthy interview with Harold Vaughn at White Mountain Realty revealed that somewhere between 1500-2000 second homes exist in the Pinetop, Lakeside and Show Low areas. Many of these are located in developments such as Pinetop Country Club,



Map1 ARIZONA


NAVAJO
APACHE
Holbrook
St. Johns
Heber
Show Low
McNary
Springerville

Map 2

Pinetop Lakes, White Mountains Country Club, and the previously mentioned Fairway Parks. He estimated that in Fairway Parks, for example, about 40 summer homes (all permanent single family structures) existed ranging in price from $30,000-$50,000. Vaughn indicated that many second homes are paid for in cash, though there are mortgages on some. There are a number of expensive five bedroom, five bath type summer homes priced around $125,000 in the country club areas. Even cabins begin at $20,000 and up. He also indicated that most of the growth has occurred during the past ten years--the number of second homes has tripled during that time; there were no country clubs or golf courses in the area 20 years ago. Generally, the area has experienced very steady growth over the past 20 years, both in permanent residents, and summer residents. The addition of the ski run, golf courses, and well-stocked lakes has aided the increased growth pattern, and Vaughn expects the total population of seasonal and permanent residents to double in the next five years. Vaughn also indicated that the demand for second homes in Heber has been increasing recently--a fact that was later confirmed by Diana Tinney of the Tinney Lumber Company in Heber. In addition, Ms. Tinney, who was familiar with a survey taken last summer by the University of Arizona, indicated that there are approximately 1,500 summer homes in the Heber area and about 4,500 total residents.

Following Vaughn's suggestions, visits were made to two of the country clubs in the area. At White Mountains Summer Homes, the guard at the entrance gate was unreceptive and would not allow entrance to the area but did say there were 460 homes within the development ranging from $35,000-$125,000 in price. There are presently ten lots available for sale and apparently no records are kept on the number of structures built

each year. The visit to the Pinetop Country Club-Pinetop Lakes area proved to be more informative. Marvin Jones was interviewed and he indicated that the area opened in 1967 and presently consists of 800 acres with 450 homes, 90 percent of which are second homes. In addition, he stated that at the White Mountains Country Club there were formerly only cabins; however, homes are currently being built as though they were for year-round occupancy. The majority of them have three bedrooms and two baths; many have fireplaces and an extra family room. The average size is 1500 square feet and the average price of $50,000. Jones indicated that no accessible records are kept on the number of homes built each year in any of the Country Club areas. Rather, records are kept on lot sales. These records can present a misleading picture of second-home construction as, four or five years ago, second home-owners bought lots with the idea of building much later; now the trend is to build immediately. Jones also stated that about one-half of the second home purchases pay cash for their dwellings while the other half mortgage their homes. He estimated that on the average, some 40 new homes are added each year, but generally the number added each year varies with the state of the economy. As for constraints on future growth, Jones felt that there were two major ones: (1) limited supply of private land and (2) the cost of building.

Several other realtors in the study area were also interviewed, one of which was a real estate agent at Lewis Realty in Holbrook. According to him there are no vacation homes in the Holbrook area at all; most are in Pinetop and Lakeside. An interview with a representative from Pinetop Realty in Pinetop revealed that second home financing is very difficult to obtain; the seller generally carries the mortgage papers. Many lots are bought for pure speculation and there is no way to distinguish between

speculators and actual second home buyers. There are no records kept on the number of homes or on prices. He indicated that there are few second homes near both St. Johns and Springerville.

The small number of second homes in the St. Johns and Springerville areas was confirmed by a representative of Jack Brown Realty in St. Johns. This individual was familiar with the area and had been in real estate for many years. He stated that there are exactly five total summer homes, two permanent structures and three of which are mobile homes. He also indicated that Snowflake is very similar to St. Johns, that is, it consists mostly of a static population. He said there were many retirees living in the St. Johns area but that the majority of summer homes are in Show Low and Pinetop due mostly to the attraction of water-related activities not available in St. Johns.

Wayne Hunt Realty at Pinetop was also contacted. A representative there estimated approximately two-three people per week seek help in finding a second home during the period from April 1 through October 1. During the winter months, most visitors are skiers or other types of weekend visitors. Generally, middle income families have cabins, ranging in price from $20,000-$25,000 up to $45,000. At the country clubs, prices average from $50,000-$60,000. Average size is 1,400-1,500 square feet; some are as large as 4,000 square feet. Most of the homes are paid for in cash; if not in cash, most buyers pay half down with a short pay-off period, usually five years. Many people build their own homes. Approximately one-third to one-half are mobile homes. She felt that an important barrier to growth is the present waste treatment problem. Waste disposal currently consists almost entirely of septic tanks; however,

there is presently a bond issue up for vote to finance an underground sewer system. She felt that more growth both commercially and residentially would result if a sewer system were installed.

As suggested by the spokesman at Wayne Hunt Realty, a visit was paid to the Pinetop Chamber of Commerce. The Director there gave me a community profile leaflet describing the major activities, facilities, services and demographic characteristics of the Show Low area. As for specific information concerning second homes, she could not provide any. However, she suggested that Mrs. Cliff Richey be contacted with regard to a recent special census of the area. This was done; however, Mrs. Richey indicated that the census was not likely to be useful in determining the number of second homes. She described the census as only a registration and voting census that mapped every fifth house in the area.

Several of the realtors interviewed suggested checking other sources including: (1) the Sitgreaves National Forest, (2) the Land Operations Division of the White Mountain Apache Enterprises, (3) the County Assessors Office in both Navajo and Apache Counties, (4) the local banks, and (5) the Navopache Electric Co-op, Inc. in order to gain a further perspective on the patter of second home development in the study area. A representative of each of these four organizations was interviewed. The information they provided will now be considered in turn.

Adrian Hill, an employee of the Sitgreaves National Forest was contacted in Pinetop. According to Mr. Hill special-use permits are issued to those wishing to build a summer home on Forest Service land and the land is leased on an annual basis. There are some 64 summer homes in the area (from McNary to Show Low) which are permanent structures only. There have been no additions within the last ten to 15 years as the summer

home areas within the National Forest are fully occupied; most of the homes were built in the forty's and fifty's; approximately one-third of homeowners built the homes themselves. Very few are mortgaged. Records exist showing how large the homes are, when they were built, and the number added each year. However, data on the value of these homes are unavailable.

Sidney Ethebaugh of the Land Operations Division of the White Mountain Apache Enterprises was also interviewed. He noted that there are approximately 425-450 summer homes in the area which includes the Hawley Lake and Hon-Dah Homesite areas. Lots averaging one-half acre in size are leased for a period of 25 years. Rental cost varies from $140 to $245 per year. There are 515 total lots available. In 1958 there were some 100 homes in the area with rental price varying from $40 to $120 per year. Building plans must be submitted and approved by White Mountain Apache Enterprises. Mr. Ethebaugh was not permitted to release market price information on the existing homes and information on annual growth is not available.

The county tax assessors in both Navajo County and Apache County were contacted in order to obtain their view on the advisability of using assessment records to estimate the number of second homes in the study area. It was felt that these interviews were of potential importance in light of the methodology used by Bond and Dunikosky for forecasting second home development in Central Arizona. According to both, there is really no way to examine property tax assessment records to determine if a residence is primary or seasonal. However, permanent structures can be distinguished from mobile homes using these records. Therefore, these records may be of some conceivable value in analyzing the composition of

the stock of second homes by type of dwelling. This aspect was not pursued, however, as a very large number of individual tax records would have required examination[3] and the resulting information would have been of questionable immediate value.

Representatives of the Valley National Bank in Show Low and First National Bank of Arizona in Pinetop were also contacted to confirm the apparent inaccessibility of mortgage funds for second homes. According to the Valley Bank, real estate loans on second homes are out of policy at the present time. Such loans can be made by securing them with something else of equal value or if the loan is requested by a special customer, but most buyers either have the cash or pay a large percent down in cash and finance only a very small part of the total cash. First National Bank makes no real estate loans on second homes; there is no money available at all for this purpose. Also, according to the home office of Valley Bank in Phoenix, for the past 12 years it has been the policy of the real estate loan department not to seek business in the area of second home financing, but to consider each application on its own merits. If the buyer is a good Valley Bank customer, there is a chance that the loan will be approved. If so, the usual terms would be 1/4 percent above the conventional rate for 20 years plus a 2 percent origination fee; the loan amount would be no more than 75 percent of value.

Finally, a lengthy interview was conducted with Tillman McDaniel at

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[3]For Apache County alone, it would have been necessary to inspect the contents of four five-drawer filing cabinets.

the Navopache Electric Co-op, Inc. in Lakeside. Mr. McDaniel expressed a willingness to make available monthly records from 1958 through 1976 which classify each utility user as either seasonal or permanent. These records give a monthly total for each category both for Navajo and Apache Counties plus a total for the two counties combined. According to McDaniel, when a new customer requests a utility connection, that customer is asked whether or not the residence will be permanently occupied. If not, and if the residence is located neither in an incorporated area nor on a farm, the customer is classified as a seasonal residential user. Also discussed with McDaniel was the possibility of distinguishing between permanent structures and mobile homes since many second homes are mobile homes. No such distinction was possible since mobile homes, in addition to fixed location dwellings, are included together in this category. Because of the manner in which this category has been defined, it is clearly comprised largely, if not exclusively, of second homes. Nevertheless, the utility connection data probably somewhat understate the number of second homes in the two counties because an unknown, but probably small, number of second home owners may choose to forego electrical service. In any event, these data were obtained and are reproduced in Appendix A.

In summary, then, the fieldwork led to the followint tentative conclusions regarding status of second home development activity in Navajo and Apache Counties.

1. There has been a great deal of second home construction during the past 10 years. Much of this construction, which has been facilitated by the development of several country clubs, has been undertaken in the Show Low-Pinetop-Lakeside area. Very

recently, second home development potential near Heber has begun to be tapped. In addition a limited number of second homes have been constructed in the Sitgreaves National Forest and on the White Mountain Apache Indian Reservation. Very few second homes exist in the vicinity of the communities of Holbrook, St. Johns, and Springerville.

2. The prospects for future second home development in the area, according to several local realtors, at least over the near term, appear bright even though second homes are not likely to be constructed on public land, such as within National Forest boundaries, there seems to be an adequate supply of private land available for this purpose. However, as Marvin Jones indicated, with a fixed supply of private land, the high rate of second home construction that the area has witnessed recently clearly cannot go on indefinitely.

3. An important constraint on second home construction that could loom large in the future relates to financing arrangements. According to the realtors interviewed, long term financing for second homes is difficult to obtain through conventional sources. This view was corroborated by officials of the Valley National Bank and First National Bank of Arizona. As a consequence, the pace of second home development in the area may decline especially if construction costs continue to escalate. Another possibility is that mobile homes which are relatively cheaper than fixed location dwellings may become an increasing percentage of the second home stock.

4. As expected, data on second homes in Navajo and Apache Counties

are difficult to obtain. It would probably be possible to piece together current estimates of the second home stock from records gathered from: (1) the Sitgreaves National Forest, (2) the White Mountain Apache Indian Reservation, (3) the various country clubs, (4) water billing documents, and (5) possibly tax assessment records. However, the most accurate as well as the most accessible data source appears to be the records kept on seasonal residential electric utility connections by the Navopache Electric Co-op, Inc.

5. THE TIME SERIES MODEL

As indicated, this section will apply time series analysis to the problem of predicting future levels of second home construction activity in Navajo and Apache Counties. Using this technique, the Navopache electric utility connections data will be examined alone rather than in concert with other economic data. In contrast to the work of Burby, Donnelly, and Weiss, this model will indicate only the county rather than the exact locations where second home development activity is likely to take place. However, a county level forecast will probably provide enough geographical detail since, in light of the previously discussed fieldwork, the most important second home development areas are already known.

Before describing the forecasting model, it might be desirable to briefly discuss two reasons for choosing this particular methodology over the construction of a complete structural model. First, just as there are no hard data on the number of second homes in the two counties, there are no data on the location of the primary residences of their

owners.[4] Consequently, it is difficult to know how to relate the past history of second home development, as measured by Navopache's utility connection data, to explanatory economic variables such as population, income, employment, market prices and construction costs. In particular, the appropriate geographical units of observation for these variables are not known. Second, even if the appropriate geographical units were known, county level observations on (or estimates of) income, employment, and population would only be available on an annual basis whereas the utility connections have been measured monthly. Market price and construction cost data for second homes would not be available at all.[5] As a result, it would appear to be undesirable to condense the utility connection series to annual averages if only to relate it to variables that may be measured inaccurately at best.

The time series approach, on the other hand, has an advantage in that it permits forecasts of future observations on a particular series to be constructed exclusively from its own past history. In other words, it is unnecessary to build a complete structural model of the second home development process in order to obtain the desired predictions. This feature is thought to be desirable in research situations where emphasis is placed on forecasting rather than on determining the relationship between second home development activity and changes in

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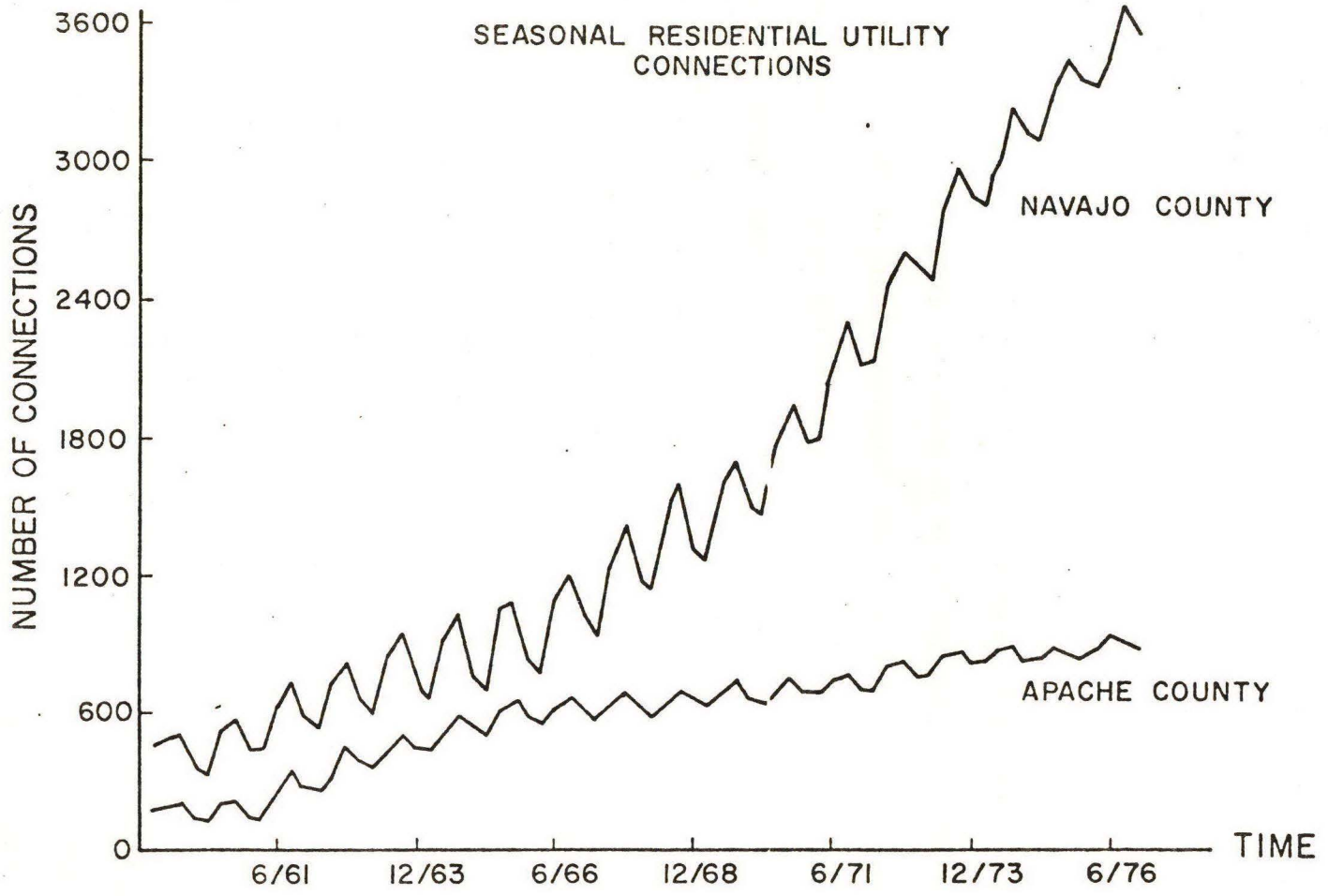
[4]It is likely that many or most second home owners in this area live in Maricopa or Pima Counties--the counties in which Phoenix and Tuscon are located. However, there is really no way to verify what percentage live in these two counties and what percentage live elsewhere.

[5]Construction cost data, however, are available for the nation as a whole.

other economic variables. However, there are obvious hazards to forecasting using what amounts to a sophisticated trend extrapolation. Numerous factors; such as income, land availability, construction costs, and tastes, could change and thereby cause second home development to shift away from its past trend. Nevertheless, provided these underlying factors are relatively slow to change, the time series approach is capable of providing short term forecasts that are sufficiently accurate to be useful for future planning.

With these limitations in mind, the utility connection data were subjected to a time series analysis in order to determine the appropriate forecasting model. The observations on utility connections in each of the two counties were assumed to have been generated by an ARIMA model. This approach has been chosen for three reasons. First, the ARIMA model can be successfully fitted to regularly behaved time series such as the two of interest which are depicted in Figure 1. Second, this model is particularly well-suited to capturing seasonal fluctuations. As Figure 1 illustrates, both series to be modelled exhibit a distinct seasonal pattern which is due largely to service disconnections on mobile homes in winter and subsequent reconnections (on possibly different units) in summer. In planning for the provision of public services, information on these winter to summer fluctuations may prove to be of at least equal importance with forecasts of average annual growth. Third, the ARIMA model embodies commonly used forecasting procedures, such as purely autoregressive formulations, as special cases. This last feature is thought to be advantageous as it provides the investigator with a measure of flexibility in determining the underlying mechanism that generated the observed series.

FIGURE I.


SEASONAL RESIDENTIAL UTILITY CONNECTIONS
NUMBER OF CONNECTIONS
3600
3000
2400
1800
1200
600
0
NAVAJO COUNTY
APACHE COUNTY
TIME
6/61
12/63
6/66
12/68
6/71
12/73
6/76

In view of the seasonality in the data on utility connections in Navajo and Apache Counties, the ARIMA process was initially specified as the following multiplicative model

$$\alpha(B)\alpha_s(B^s)(1-B)^d(1-B^s)^D x_t = \beta(B)\beta_s(B^s)\varepsilon_t \qquad (1)$$

where α and α_s are p and p* degree polynomials in the backward operator, B, whose coefficients are the model's regular and seasonal autoregressive parameters, β and β_s are q and q* degree polynomials in B whose coefficients are the model's regular and seasonal moving average parameters, x_t denotes the $t^{\underline{th}}$ observation in the series on utility connections in either Navajo (N) or Apache (A) counties, d and D denote the number of regular and seasonal differences required to convert x_t to a stationary series, and ε_t denotes the $t^{\underline{th}}$ measurement on a white noise process.

As a number of authors including BOX and JENKINS (1976) and GRANGER and NEWBOLD (1977) have indicated, constructing an appropriate forecasting model from Equation (1) often involves a considerable amount of experimentation. That is, it is necessary to iterate through several rounds of model identification, estimation, and diagnostic checking before deciding on a most desirable specification. Needless to say, only those experiments underlying the final version of the two models can be reported here; however, some further results are available from the author on request. Regarding model identification, it was observed from the sample autocorrelations of the original series that neither could be considered a stationary process. However, taking first and then twelfth differences, (d=1, D=1, s=12) produced the sample autocorrelations (r_k) and partial autocorrelations ($\hat{a}_{kk}$) shown in Tables 2 and 3.

TABLE 2

SAMPLE AUTOCORRELATIONS AND PARTIAL AUTOCORRELATIONS

FOR DIFFERENCED DATA ON UTILITY CONNECTIONS IN

NAVAJO COUNTY: $(1-B)(1-B^{12})N_t$*

k	1	2	3	4	5	6	7	8	9	10	11	12
r_k	-.41	-.01	-.06	.05	-.03	-.02	.05	-.03	.04	-.01	.24	-.49
$\hat{a}_{kk}$	-.41	-.22	-.19	-.09	-.09	-.09	-.01	-.03	.03	.03	.34	-.30
k	13	14	15	16	17	18	19	20	21	22	23	24
r_k	.26	-.03	.05	-.05	.04	.03	-.08	.02	-.05	.05	-.01	.03
$\hat{a}_{kk}$	-.02	-.02	.01	.00	.03	.05	-.03	-.03	-.08	-.03	.19	-.19
k	25	26	27	28	29	30	31	32	33	34	35	36
r_k	-.06	.07	-.03	.02	-.02	-.06	.05	-.05	.11	.00	-.11	-.02
$\hat{a}_{kk}$	-.03	.03	.03	.02	.04	-.04	-.05	-.10	.02	.11	.04	-.24

*Standard errors for the sample autocorrelations ($SE(r_k)$) were: $SE(r_1)=.07$; $SE(r_k)=.08$, k=2,12; $SE(r_k)=.10$, k=13,36, while standard errors for the sample partial autocorrelations are approximately equal to $n^{-1/2}=.07$.

Number of observations (n)=203.

TABLE 3

SAMPLE AUTOCORRELATIONS AND PARTIAL AUTOCORRELATIONS

FOR DIFFERENCED DATA ON UTILITY CONNECTIONS IN

APACHE COUNTY: $(1-B)(1-B^{12})A_t$*

k	1	2	3	4	5	6	7	8	9	10	11	12
r_k	-.24	.14	.07	.09	-.10	-.03	.04	-.06	-.05	-.12	.28	-.41
$\hat{a}_{kk}$	-.24	.09	.13	.13	-.09	-.12	.01	-.01	-.04	-.16	.25	-.28
k	13	14	15	16	17	18	19	20	21	22	23	24
r_k	.23	.08	.04	-.06	.12	-.02	-.01	-.01	-.01	.03	-.11	.08
$\hat{a}_{kk}$	.10	.20	.07	-.04	.00	-.06	.02	.01	-.01	-.07	.12	-.10
k	25	26	27	28	29	30	31	32	33	34	35	36
r_k	-.07	-.02	-.03	.12	-.15	.09	-.06	-.01	.01	-.03	.10	-.15
$\hat{a}_{kk}$	-.01	.05	-.02	.04	-.10	.01	-.06	-.04	.04	-.05	.17	-.19

*Standard errors for the sample autocorrelations ($SE(r_k)$) were: $SE(r_k)=.07$; $k=1,9$; $SE(r_k)=.08$; $k=10,12$; $SE(r_k)=.09$; $k=13,25$; $SE(r_k)=.10$, $k=26,36$ while the standard errors for the sample partial autocorrelations are approximately equal to $n^{-1/2}=.07$, number of observations (n)=203.

As Table 2 indicates, all of the parent autocorrelations (ρ_k) for the differenced utility connections series for Navajo County appear to be approximately zero except for ρ_1, ρ_{11}, ρ_{12}, ρ_{13}. The estimates of these four parameters are all at least twice as large in absolute value as their standard errors while none of the remaining $|r_k|$ exceed their standard errors. Moreover, the partial autocorrelations appear to die out; though not in any clearly recognizable pattern. These results, as GRANGER and NEWBOLD (1977, p. 96) have indicated, suggest that the model for Navajo County might be tentatively identified as either of the following two processes:

$$(1-B)(1-B^{12})N_t = (1-b_1B)(1-b_{12}B^{12})\varepsilon_t \qquad (2)$$

$$(1-B)(1-B^{12})N_t = (1-b_1B-b_{12}B^{12}-b_{13}B^{13})\varepsilon_t \qquad (3)$$

As may easily be demonstrated, Equation (3) is identical to Equation (2) except that the coefficient on B^{13} has not been constrained to equal the negative of the product of b_1 and b_{12}.

Table 3, on the other hand, shows that properties of the differenced utility connections series for Apache County are similar to those for Navajo County. Again, the parent autocorrelations ρ_1, ρ_{11}, ρ_{12}, and ρ_{13} would appear to be significantly different from zero. Quite possibly, however, both ρ_2 and ρ_{10} are also significantly different from zero since r_2 is twice as large as its standard error while r_{10} exceeds its standard error by a factor of 1.5. Further, using the fact that the $\hat{a}_{kk}$ do not

decay in the manner of an autoregressive process, these results would appear to have been generated by a model similar to either.[6]

$$(1-B)(1-B^{12})A_t = (1-b_1B-b_2B^2)(1-b_{12}B^{12})\varepsilon_t \qquad (4)$$

or

$$(1-B)(1-B^{12})A_t = (1-b_1B-b_2B^2-b_{12}B^{12}-b_{13}B^{13}-b_{14}B^{14}) \qquad (5)$$

As was the case with Equations (2) and (3), Equation (5) is equivalent to Equation (4) except for the absence of parametric restrictions on B^{13} and B^{14}.

The parameters in Equations (2) through (5) were estimated using the Marquardt non-linear least squares algorithm. This algorithm is described in BOX and JENKINS (1976, pp. 504-505), while a general discussion of the application of non-linear least squares to time series models is provided in the same reference. In any case, after estimation, neither the tentatively identified models for Navajo County nor those for Apache County were regarded as acceptable representations of the true models. An analysis of the residuals from all four estimated equations revealed significant departures from white noise behavior. To remedy this problem, Equation (3) for Navajo County and Equation (5) for Apache County were modified both by fitting extra moving average coefficients and by eliminating those coefficients that were originally insignificantly different from zero at the 5 percent level. These modifications

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[6] Actually, for either Equations (4) or (5) to be the correct model, ρ_{14} would have to be non-zero; an unlikely prospect since $r_{14}/SE(r_{14})=.89$. Consequently, these two specifications were viewed as points of departure in determining the appropriate form of the forecasting model for Apache County.

produced the improved models for each county that are reported in Tables 4 and 5. Table 4 shows that estimates of regular moving average parameters of orders 1, 11, 12, and 13 for Navajo County are different from zero at the 5 percent level of significance. In addition, Table 5 indicates that for Apache County, estimates of four of the five regular moving average parameters were different from zero at the same significance level. Even though it was not significant, the coefficient of ε_{t-1} was retained in order to improve the forecasting properties of the model.[7]

Based upon the examination of both the autocorrelations of the estimated residuals it would appear that the estimated models reported in Tables 4 and 5 provide an acceptable representation of their respective true models. The residual autocorrelations ($r_k(\hat{\varepsilon})$) are shown in Tables 6 and 7. The evidence presented in these tables does not contradict the hypothesis that, in models which were estimated for both counties, the true residuals constitute a white noise process. This hypothesis was investigated in two ways. First, following the suggestion of GRANGER and NEWBOLD (1977, p. 92), the $r_k(\hat{\varepsilon})$, k=1,36 were compared with twice their standard errors in an effort to detect individual autocorrelations that differed significantly from zero. Since, in Table 6, the largest value of $|r_k(\hat{\varepsilon})|/SE(r_k(\hat{\varepsilon}))$, which occurred at k=10, was 1.43 and in Table 7, the largest value of this ratio, appearing at k=3, was 1.57, the null hypothesis that ε_t is white noise was not rejected. Second,

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[7] An experiment comparing the sample period forecasting errors of the model reported in Table 4 with those of the same model but with $b_1=0$ revealed that the reported model performed somewhat better in the root mean square error sense.

TABLE 4

NON-ZERO COEFFICIENT ESTIMATES IN NAVAJO

COUNTY EQUATION: $(1-B)(1-B^{12})N_t = \sum_{j=1}^{\infty} \hat{b}_j \epsilon_{t-j}$

Parameter Type	Parameter Order	Estimated Value	95% Confidence Interval	
			Lower Limit	Upper Limit
Regular Moving Average	1	-.425	-.545	-.305
Regular Moving Average	11	.131	.040	.221
Regular Moving Average	12	-.780	-.868	-.691
Regular Moving Average	13	.583	.459	.706

TABLE 5

NON-ZERO COEFFICIENT ESTIMATES IN APACHE

COUNTY EQUATION: $(1-B)(1-B^{12})A_t = \sum_{j=1}^{\infty} \hat{b}_j \varepsilon_{t-j}$

Parameter Type	Parameter Order	Estimated Value	95% Confidence Interval	
			Lower Limit	Upper Limit
Regular Moving Average	1	-.102	-.233	.029
Regular Moving Average	2	.174	.076	.273
Regular Moving Average	11	.215	.114	.317
Regular Moving Average	12	-.600	-.708	-.491
Regular Moving Average	13	.379	.241	.517

TABLE 6

RESIDUAL AUTOCORRELATIONS FROM ESTIMATED

EQUATION FOR NAVAJO COUNTY*

k	1	2	3	4	5	6	7	8	9	10	11	12
$r_k(\hat{\varepsilon})$	.06	-.06	-.09	-.05	-.01	-.05	.02	-.01	.05	.10	.09	-.02
k	13	14	15	16	17	18	19	20	21	22	23	24
$r_k(\hat{\varepsilon})$	-.01	-.01	.00	-.02	.02	-.05	-.07	-.07	.00	.08	.00	-.03
k	25	26	27	28	29	30	31	32	33	34	35	36
$r_k(\hat{\varepsilon})$	-.02	.07	.01	-.02	-.07	-.10	.01	-.03	.05	.00	-.08	.00

*Standard errors for the $r_j(\hat{\varepsilon})$, $SE(r_j(\hat{\varepsilon}))$, are $SE(r_j(\hat{\varepsilon}))=.07$ $j=1,29$ and $SE(r_j(\hat{\varepsilon}))=.08$ $j=30,36$.

TABLE 7

RESIDUAL AUTOCORRELATIONS FROM THE ESTIMATED

EQUATION FOR APACHE COUNTY*

k	1	2	3	4	5	6	7	8	9	10	11	12
$r_k(\hat{\varepsilon})$	.05	-.02	.11	.07	-.08	-.03	-.01	-.05	-.07	-.09	.07	.02
k	13	14	15	16	17	18	19	20	21	22	23	24
$r_k(\hat{\varepsilon})$	.00	.06	.10	-.01	.05	.04	-.04	-.05	.02	-.01	-.05	.00
k	25	26	27	28	29	30	31	32	33	34	35	36
$r_k(\hat{\varepsilon})$	-.05	-.02	.04	.01	-.05	.04	-.09	-.06	.06	.03	.00	-.08

*Standard errors for the $r_j(\hat{\varepsilon})$, $SE(r_j(\hat{\varepsilon}))$, are $SE(r_j(\hat{\varepsilon}))=.07$ $j=1,23$ and $SE(r_j(\hat{\varepsilon}))=.08$ $j=24,36$.

BOX and PIERCE (1970) have shown that an overall test of this hypothesis may be conducted using the statistic

$$Q = n \sum_{k=1}^{M} r_k^2(\hat{\varepsilon}) \tag{6}$$

which is distributed as χ^2_{M-N} where N is equal to the number parameters to be estimated. The value of Q for the Navajo County equation was equal to 16.92 while its counterpart for the Apache County equation was 16.34. Both of these statistics, which were calculated using M=30, indicate that a null hypothesis of white noise behavior for the ε_t would not be rejected at the 10 percent level of significance.

As another check on the appropriateness of the two models, forecasts of utility connections for the last 60 months of the sample period (January, 1972, through December, 1976) were constructed using the first 156 observations and then were compared with their actual values. Both of the forecasted series exhibited much the same seasonal pattern as did the actual series shown in Figure 1. In addition, the errors in forecasting individual observations were within reasonable limits. The root mean square prediction error; calculated as

$$E = \sqrt{\frac{\sum_{i=1}^{T} (F_i - A_i)^2}{T}} \tag{7}$$

where F_i denotes the forecasted value in month i, A_i denotes the actual value, and T denotes the number of months used to compute the measure (in this case, 60); for Navajo County was 112.86 and for Apache County this measure turned out to be 21.54. These values are but 3.3 percent and 2.3 percent of an average of the last 12 observations on each series, respectively.

TABLE 8

FIVE YEAR FORECAST OF SECOND HOME

CONSTRUCTION IN NAVAJO AND APACHE COUNTIES

Month	Apache County	Navajo County
3/77	914	3536
6/77	948	3676
9/77	992	3865
12/77	949	3744
3/78	934	3745
6/78	968	3885
9/78	1012	4075
12/78	969	3953
3/79	954	3954
6/79	988	4094
9/79	1032	4284
12/79	989	4162
3/80	974	4163
6/80	1008	4303
9/80	1052	4493
12/80	1009	4371
3/81	994	4372
6/81	1028	4512
9/81	1072	4702
12/81	1029	4581

Finally, since the two models performed to within tolerable error limits over the latter part of the sample period, monthly forecasts were prepared for the five-year period January, 1977 through December, 1981. To economize on space, Table 8 presents these forecasts only for the months of March, June, September and December. Nevertheless, it is still evident that the forecasts follow a distinct seasonal pattern that is quite similar to the original data set. In addition, Table 8 shows that the time series models forecast a 10.76 percent increase in the number of second homes in Apache County and a 29.22 percent increase in Navajo County.[8] This indicates the potential for a substantial increase in the seasonal population of especially Navajo County.

4. CONCLUSION

This paper has presented a simple method for predicting the future number of second homes in a given area. It was argued that such a method is of importance since local planners can best work to reduce unwanted side-effects from second home construction when their probable numbers are known in advance. The forecasting method itself is based upon a Box-Jenkins type of univariate time series extrapolation of seasonal residential electrical utility connections. These utility connections served as a proxy variable for the number of second homes. The method, which is illustrated using data from Navajo and Apache Counties in Arizona, is shown to provide within sample period forecasts that are within tolerable error limits.

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[8]The number of seasonal residential utility connections in Apache and Navajo Counties were, respectively, 929 and 3545 in December 1976.

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